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$$P_6(\mu) = \frac{1}{16}(231\mu^6 - 315\mu^4 + 105\mu^2 - 5).$$

$$P_4(\mu) = \frac{1}{8}(35\mu^4 - 30\mu^2 + 3). \quad P_2(\mu) = \frac{1}{2}(3\mu^2 - 1).$$

$$\therefore \sin^3 \theta \cos^3 \theta \sin^2 \phi \cos \phi = -\frac{1}{4}\frac{1}{4}(11\mu^3 - 3\mu)(1-\mu^2)^{\frac{3}{2}} \cos 3\phi$$

$$-\frac{3}{4}\frac{1}{4}\mu(1-\mu^2)^{\frac{3}{2}} \cos 3\phi - \frac{1}{1}\frac{1}{2}\frac{1}{2}(33\mu^5 - 30\mu^3 + 5\mu)\sqrt{(1-\mu^2)} \cos \phi$$

$$+\frac{1}{8}\frac{1}{8}(7\mu^3 - 3\mu)\sqrt{(1-\mu^2)} \cos \phi + \frac{1}{1}\frac{1}{2}\mu\sqrt{(1-\mu^2)} \cos \phi.$$



## PROBLEMS FOR SOLUTION.

### ARITHMETIC.

**162.** Proposed by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.

A trolley road is built between two towns, and it is found that the gross annual receipts amount to 20% of the original cost; the annual cost of repairs is 2% of the original cost; and the working expenses is \$3000 in addition to 20% of the net receipts. After a year a second road is built at the same cost as the first and it is found that the gross receipts and working expenses per year are doubled, while the cost of repairs for the new road is 1% of cost. If the net receipts for both roads is \$72,500, find the cost of each road, and the net receipts the first year.

**163.** Proposed by CHRISTIAN HORNUNG, A.M., Professor of Mathematics, Heidelberg University, Tiffin, O.

Three Dutchmen and their wives went to market to buy hogs. The names of the men were Hans, Klaus and Hendricks, and of the women, Gertrude, Anna and Katrine; but it was not known which was the wife of each man. They each bought as many hogs as each man or woman paid shillings for each hog, and each man spent three guineas more than his wife. Hendricks bought 23 hogs more than Gertrude, and Klaus bought 11 more than Katrine. What was the name of each man's wife?

### ALGEBRA.

**166.** Proposed by MARCUS BAKER, U. S. Geological Survey, Washington, D. C.

Solve

$$ax+by=2zx \dots [1].$$

$$cy+dz=2xy \dots [2].$$

$$ez+fx=2yz \dots [3].$$

**167.** Proposed by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.

A weight of  $m$  pounds falls and is broken into  $n$  pieces after which it is found that all weights, in pounds, from 1 to  $m$  can be weighed. Find the weight of each piece. Apply when  $m=121$ ,  $n=5$ .